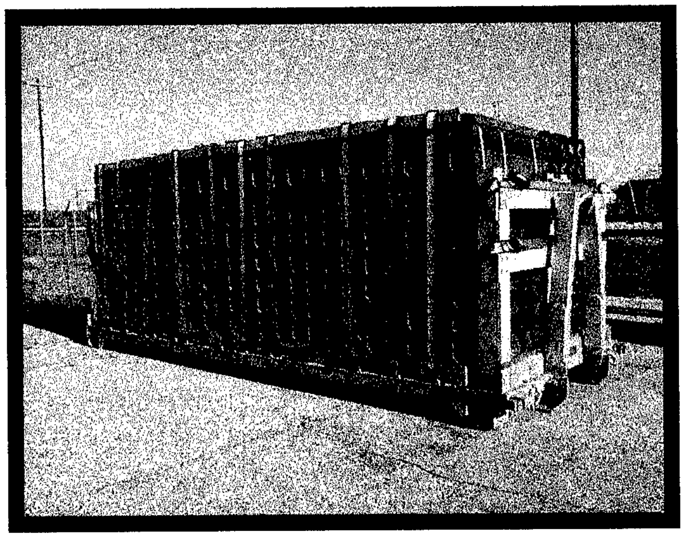
FINAL REPORT
AUGUST 2000

REPORT NO. 98-09



M3A1 HYUNDAI CONTAINER ROLL-IN/ROLL-OUT PLATFORM (CROP)

TP-94-01, Transportability Testing Procedures

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited
Distribution Unlimited

Prepared for:

U.S. Army Tank-automotive and Armaments Command
ATTN: AMSTA-DSA-HT
Warren, MI 48397-5000

VALIDATION ENGINEERING DIVISION
MCALESTER, OKLAHOMA 74501-9053

AVAILABILTY NOTICE

A copy of this report will be furnished each attendee on automatic distribution. Additional copies or authority for reprinting may be obtained by written request from:

Director
U.S. Army Defense Ammunition Center
ATTN: SMAAC-DEV
1 C Tree Road, Bldg. 35
McAlester, OK 74501-9053

DISTRIBUTION INSTRUCTIONS

Destroy this report when no longer needed. Do not return.

***

Citation of trade names in this report does not constitute an official endorsement.

***

The information contained herein will not be used for advertising purposes.

REPORT NO. 98-09 June 2000

M3A1 HYUNDAI CONTAINER ROLL-IN/ROLL-OUT PLATFORM (CROP)

TP-94-01, Transportability Testing Procedures

ABSTRACT

The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SMAAC-DEV), was tasked by the U.S. Army Tank-automotive and Armaments Command to conduct a First Article Test (FAT) on the Container Roll-In/Roll-Out Platform (CROP) manufactured by Hyundai Precision America, San Diego, California.

The CROPs were tested and evaluated in accordance with the testing procedures of TP-94-01, "Transportability Testing Procedures". Testing included rail impact tests at 4, 6, and 8.1 mph forward and 8.1 mph in the reverse direction, hazard course, and road course. The satisfactory performance of the Hyundai CROPs during testing has demonstrated that they are adequate to transport ammunition.

Prepared by:

PHILIP W. BARICKMAN
Lead Validation Engineer

Reviewed by:

JERRY W. BEAVER
Chief, Validation Engineering Division

U.S. ARMY DEFENSE AMMUNITION CENTER

VALIDATION ENGINEERING DIVISION
MCALESTER, OK 74501-9053

REPORT NO. 98-09

M3A1 HYUNDAI CONTAINER ROLL-IN/ROLL-OUT PLATFORM (CROP)
TP-94-01, Transportability Testing Procedures

TABLE OF CONTENTS

PART 1 – INTRODUCTION

A. **BACKGROUND**. The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SMAAC-DEV), was tasked by the U.S. Army Tank-automotive and Armaments Command (TACOM) to conduct a First Article Test (FAT) on the M3A1 Container Roll-In/Roll-Out Platform (CROP) manufactured by Hyundai Precision America of San Diego, California.

B. **AUTHORITY**. This test was conducted IAW mission responsibilities delegated by the U.S. Army Operations and Support Command (Prov), Rock Island, IL. Reference is made to the following:

1. Change 6, AR 740-1, 18 August 1976, Storage and Supply Activity Operation.

2. IOC-R, 10-23, Mission and Major Functions of USADAC, 7 January 1998.

C. **OBJECTIVE**. The objective of the tests was to determine if the Container Roll-In/Roll-Out Platform (CROP) manufactured by Hyundai Precision America satisfied the transportability requirements of TP-94-01.

D. **CONCLUSION**. The Hyundai Container Roll-In/Roll-Out Platforms (CROPs) were tested in accordance with TP-94-01, “Transportability Testing Procedures.” Minor deficiencies were found during testing, but they had no impact on the ability of the trailers to safely transport ammunition. The deficiencies are detailed in Section 6 of this report. The satisfactory performance of the CROPs during testing has demonstrated that they are adequate to transport ammunition.

PART 2 - ATTENDEES

DATES PERFORMED: 16 June 1998 – 4 November 1998

ATTENDEE	MAILING ADDRESS
Jerome Krohn Supv General Engineer	Director U.S. Army Defense Ammunition Center ATTN: SMAAC-DEV 1 C Tree Road, Bldg. 35 McAlester, OK 74501-9053
Gregory Willis Industrial Engineer DSN 956-8075 (918) 420-8075	Director U.S. Army Defense Ammunition Center ATTN: SMAAC-DET 1 C Tree Road, Bldg. 35 McAlester, OK 74501-9053
William Frerichs Supv General Engineer DSN 956-8071 (918) 420-8071	Director U.S. Army Defense Ammunition Center ATTN: SMAAC-DET 1 C Tree Road, Bldg. 35 McAlester, OK 74501-9053
John Simons Industrial Engr Technician	Director U.S. Army Defense Ammunition Center 1 C Tree Road, Bldg. 35 McAlester, OK 74501-9053
Charles Smithson Assistant Project Manager	Office of the Program Manager Heavy Tactical Vehicles ATTN: AMSTA-DSA-HT Warren, MI 48397-5000

PART 3 - TEST EQUIPMENT

CONTAINER ROLL-IN/ROLL-OUT PLATFORM (CROP)

Model No. M3A1

Serial No. YUMA 2029, YUMA 2101, YUMA 16316, YUMA 17112, YUMA 22286*

Tare Wt. 4,000 lbs. (1814kg)

Payload Wt. 32,250 lbs. (14629kg)

Max Gross Wt. 36,250 lbs. (16,443kg)

NSN: 3990 01 450 5671

Contract No. DAAE07-97-C-X106

Manufacturer: Hyundai Precision America

*__Note__: Five (5) CROPs were delivered for testing.

PART 4 - TEST PROCEDURES

The test procedures outlined in this section were extracted from TP-94-01, "Transportability Testing Procedures," dated July 1994. This document identifies the testing requirements for validating tactical vehicles and outloading procedures used for shipping munitions by intermodal freight containers, commercial or tactical truck, or trailer or railcar. The transportability tests that were conducted on the CROPs are summarized below.

The rail impact test was conducted with the loaded CROPs in an ISO container secured to the railcar, CROP on the PLS truck secured to a railcar, CROPs on the PLS trailer secured to a railcar, and with the CROPs secured directly to the railcar. Inert (non-explosive) items were used to build the load. The weight and physical characteristics (weights, physical dimensions, center of gravity, etc.) of the test loads were identical to live (explosive) ammunition.

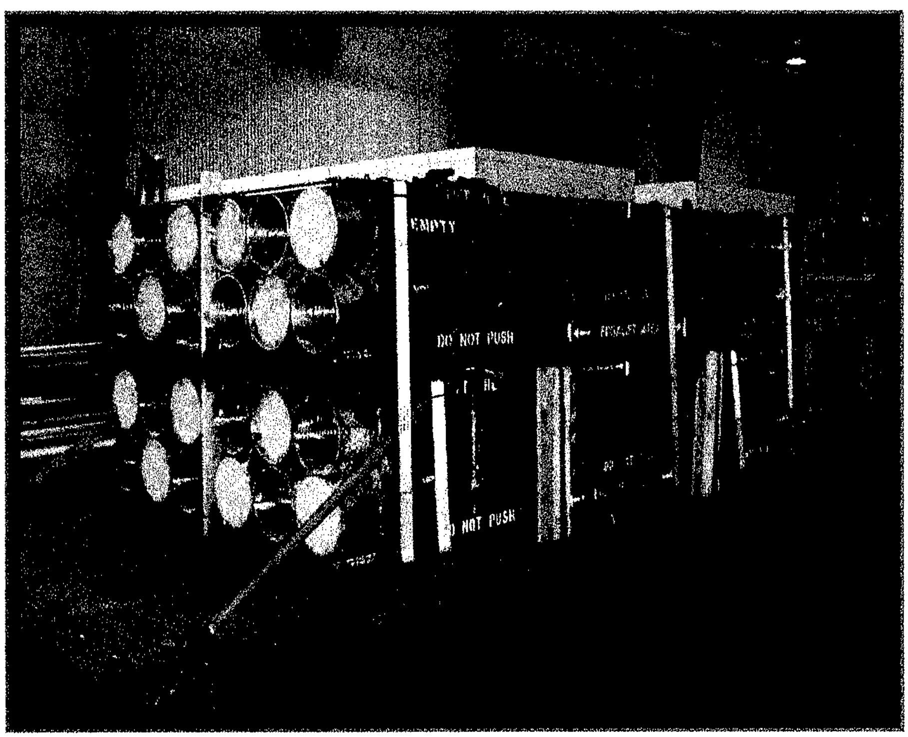


Photo No 1. MLRS pods on the CROP

A. **RAIL IMPACT TEST METHOD**. The CROPs were loaded and secured to a conventional friction draft gear flatcar. Equipment needed to perform the test included the specimen (hammer) car, four empty railroad cars connected together to serve as the anvil, and a railroad locomotive. The anvil cars were positioned on a level section of track with air and hand brakes set and with draft gears compressed. The locomotive unit pushed the specimen car toward the anvil at a predetermined speed, then disconnected from the specimen car approximately 50 yards away from the anvil cars allowing the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the reverse direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph is a minimum. Impact speeds were determined by using an electronic counter to measure the time for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1).

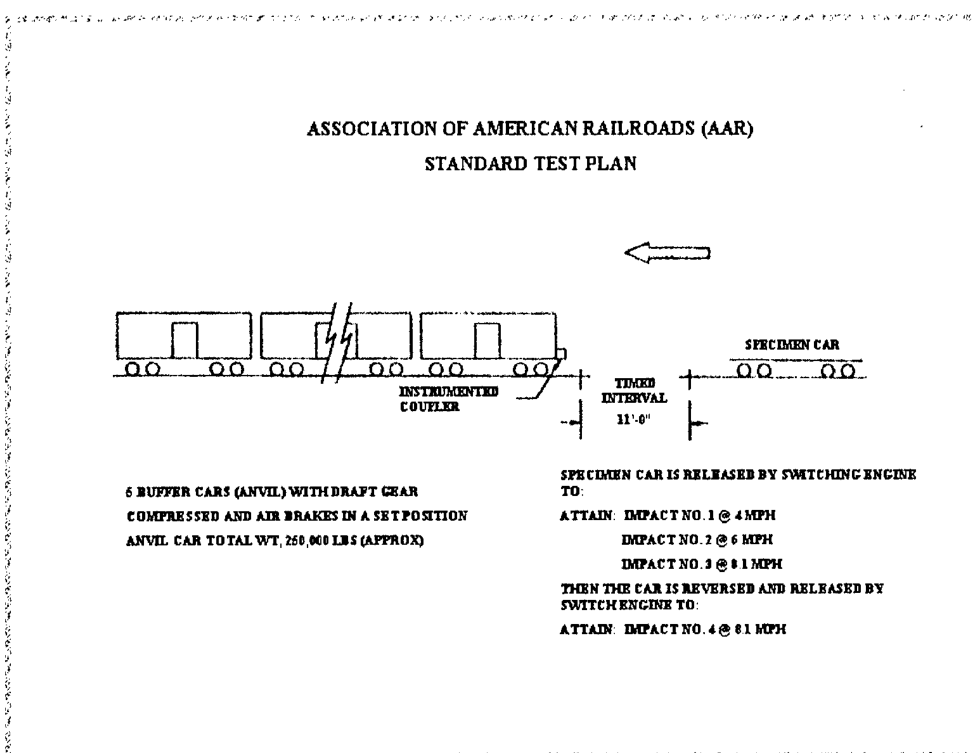


Figure 1. Rail Impact Sketch

B. HAZARD COURSE. The loaded CROPs were transported over the 200-foot-long segment of concrete-paved road consisting of two series of railroad ties projecting 6 inches above the level of the road surface. The CROPs were tested in the following configuration:

- Loaded CROP secured in an ISO container on an M872 trailer
- Loaded CROP on the PLS trailer
- Loaded CROP on the PLS truck

The hazard course was traversed two times (see Figure 2).

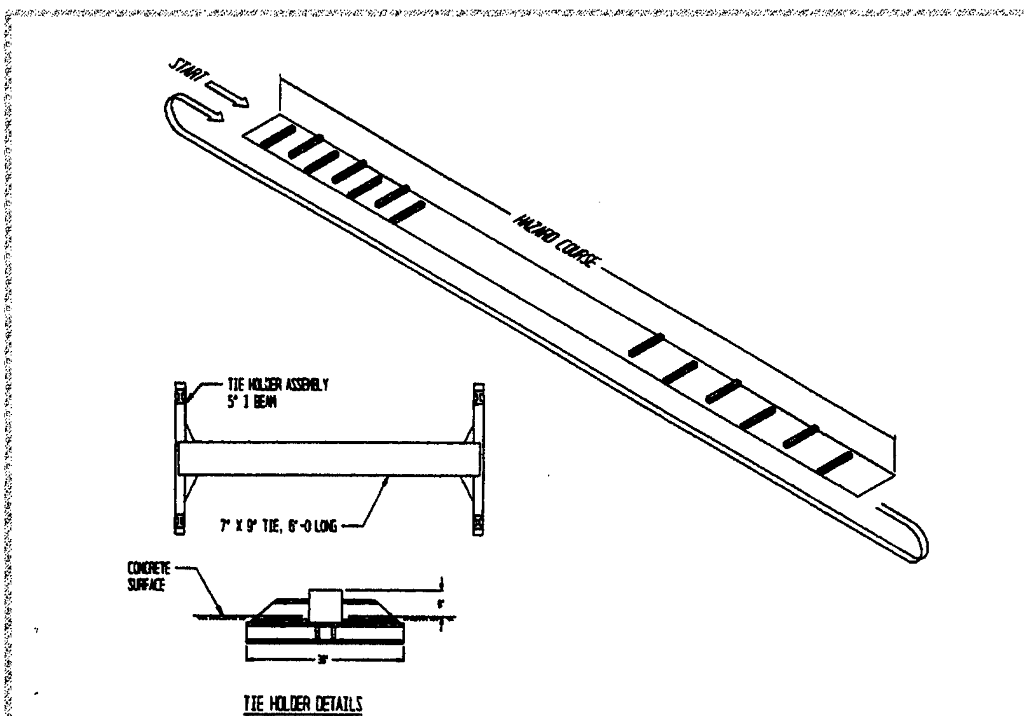


Figure 2. Hazard Course Sketch

1. The first series of ties are spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

2. Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

3. The second series of ties are spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

4. The test load is driven across the hazard course at speeds that would produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

C. ROAD TRIP. The loaded CROPs were transported for a distance of 30 miles over a combination of roads surfaced with gravel, concrete and asphalt. The test route included curves, corners, railroad crossings and stops and starts. The trailers traveled at the maximum speed for the particular road being traversed, except as limited by legal restrictions. The CROPs were tested in the following configuration:

- Loaded CROP secured in an ISO container on an M872 trailer.
- Loaded CROP on the PLS trailer.
- Loaded CROP on the PLS truck.

D. PANIC STOPS. Panic stop testing was not performed since the loads were previously rail impact tested.

E. WASHBOARD COURSE. The loaded CROPs were driven over the washboard course at a speed which produced the most violent response in the trailers. The CROPs were transported inside an ISO container, on the PLS truck, PLS trailer, and on the M872 trailer.

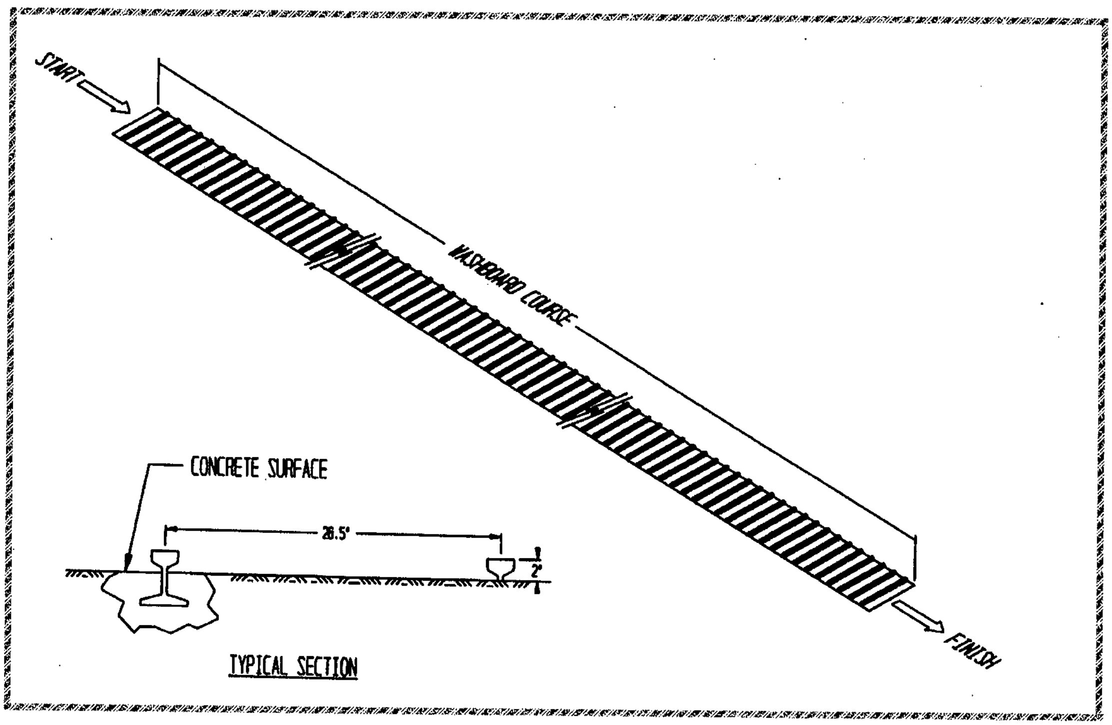


Figure 3. Washboard Course Sketch

F. <u>SHIPBOARD TRANSPORTATION SIMULATOR (STS) TEST METHOD</u>.

The intermodal container shall be positioned onto the STS and securely locked in place using the cam locks at each corner. The STS shall begin oscillating at an angle of 30 degrees plus or minus 2 degrees, either side of center and at a frequency of 2 cycles-per-minute (30 plus or minus 2 seconds total roll period). This frequency shall be observed for apparent defects that could cause a safety hazard. The frequency of oscillation shall then be increased to 4 cycles-per-minute (15 seconds plus or minus one second per roll period) and the apparatus operated for 2 hours. If an inspection of the load does not indicated and impending failure, the frequency of oscillation shall be further increased to 5 cycles-per-minute (12 seconds plus or minus one second cycle time), and the apparatus operated for 4 hours. The operation does not have to be continuous; however, no change or adjustments to the load or load restraints shall be permitted at any time during the test. After once being set in place, the test load (specimen) shall not be removed from the apparatus until the test has been completed or is terminated.

PART 5 - TEST RESULTS

A. RAIL IMPACT DATA

Test Date: 16 June 1998

Specimen Load: 155MM on CROP in ISO Container on COFC.

Remarks: Six pallet loads shifted vertically. The A-frame slacked 0.25 inch.

Test Date: 7 July 1998

Specimen Load: MLRS Pods and 105MM in ISO Container on COFC.

Remarks: MLRS- Deadbolt pins bent during the rail impact test and were difficult to remove. The rub strips scraped off during containerization.

Test Date: 9 July 1998

Specimen Load: 155MM in an ISO container and 105MM on modified CROP on COFC.

Remarks: Six pallet loads shifted vertically. No problems with CROP.

Test Date: 19 August 1998

Specimen Load: 120MM and 155MM on CROPs and secured to wood deck railcar.

Remarks: No problems with CROPs and/or loads. The CROP with 155MM load has aluminum side strips. (See Photo 2).

Photo No. 2. 120MM on the CROP

Test Date: 20 August 1998

Specimen Load: 155MM on PLS trailer on wood deck with chain tiedown.

Remarks: No problems with the CROP and/or load.

Test Date: 21 August 1998

Specimen Load: 120MM on PLS trailer on wood deck flatcar with chain tiedown.

Remarks: No problems with the CROP and/or load.

Test Date: 25 August 1998

Specimen Load: 120MM in ISO container on COFC.

Remarks: No problems with the CROP and/or load.

Test Date: 16 September 1998

Specimen Load: MLRS and 105MM in ISO container on COFC.

Remarks: The front bottom gate on 105MM broke. No problems with CROPs. Load will be retested.

Test Date: 21 September 1998

Specimen Load: MLRS in ISO container on COFC.

Remarks: New strapping methods passed testing although two straps came loose after impact.

Test Date: 24 September 1998

Specimen Load: 105MM on CROPs and secured to wood deck flatcar with chain tiedowns.

Remarks: The gate at the front end broke during impact and the second layer slid and rested against the A-frame.

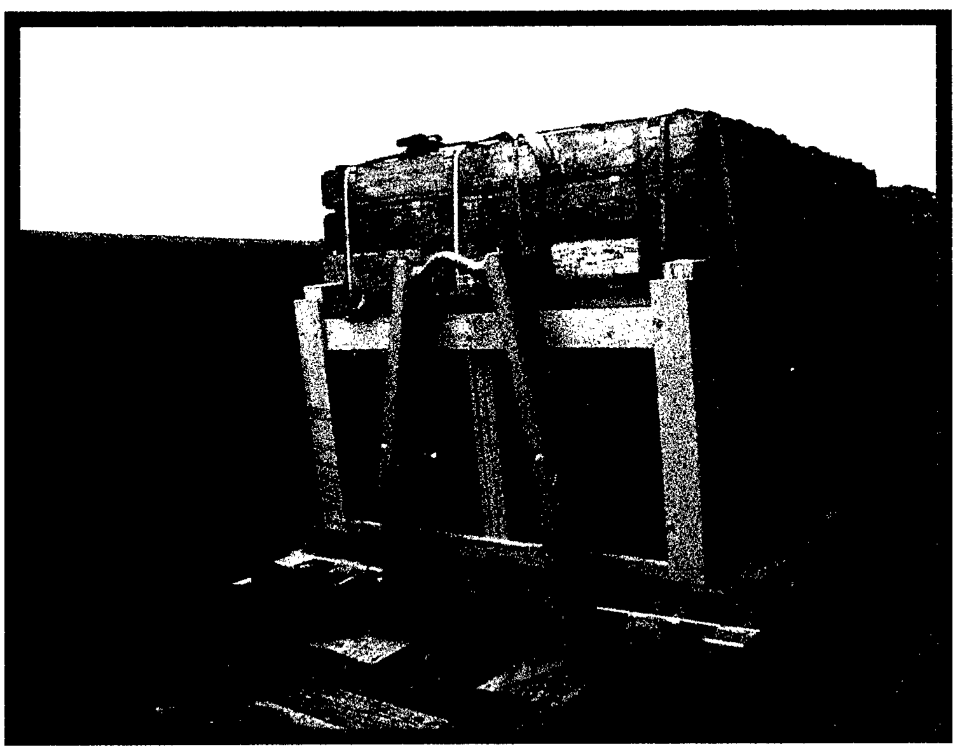


Photo No. 3. 105MM on the CROP on a flatcar

Test Date: 9 November 1998

Specimen Load: 105MM on PLS trailer and chained to flatcar.

Remarks: No problems with the CROP and/or load.

Test Date: 10 November 1998

Specimen Load: MLRS on PLS trailer and chained to flatcar.

Remarks: No problems with the CROP and/or load.

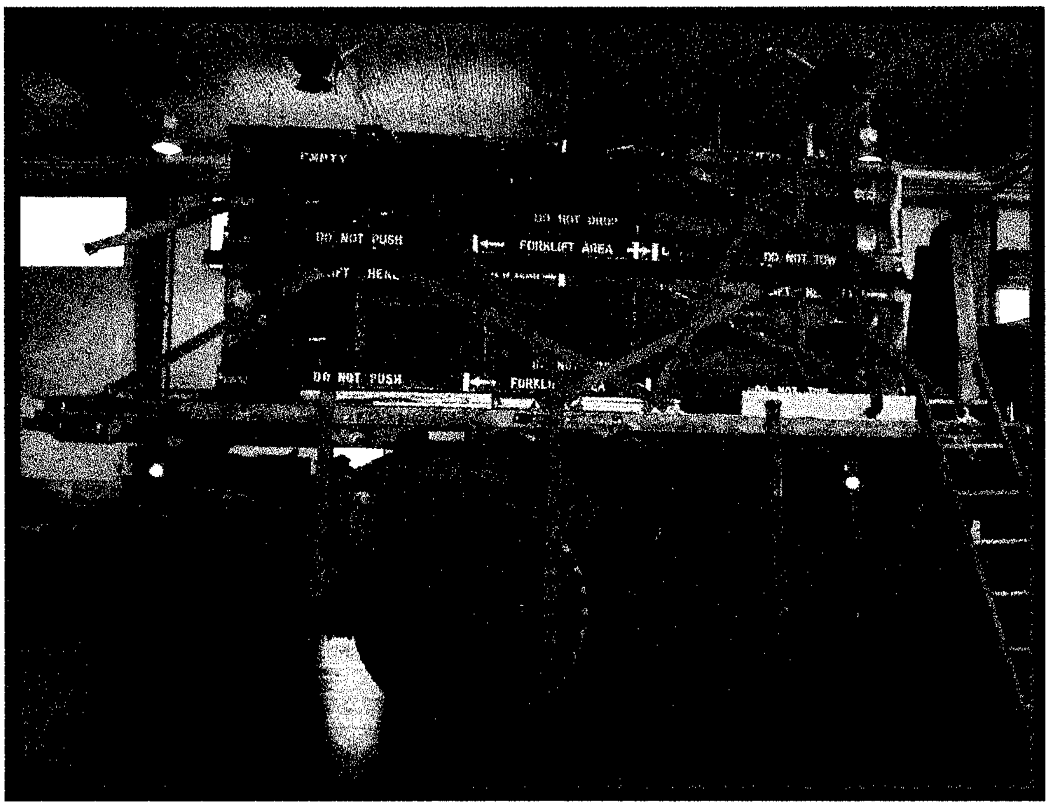


Photo No. 4. MLRS pods on the CROP on the PLS trailer

Test Date: 18 November 1998

Specimen Load: MLRS pods on the CROP on the PLS truck and secured to the railcar.

Remarks: No problems with the CROP and/or load.

Test Date: 19 November 1998

Specimen Load: 105MM on the CROP on the PLS truck and secured to the railcar.

Remarks: No problems with the CROP and/or load.

Test Date: 1 December 1998

Specimen Load: 155MM on the CROP on the PLS truck and secured to the railcar.

Remarks: No problems with the CROP and/or load.

B. HAZARD COURSE/ROAD TRIP/WASHBOARD

Test Date: 17 June 1998

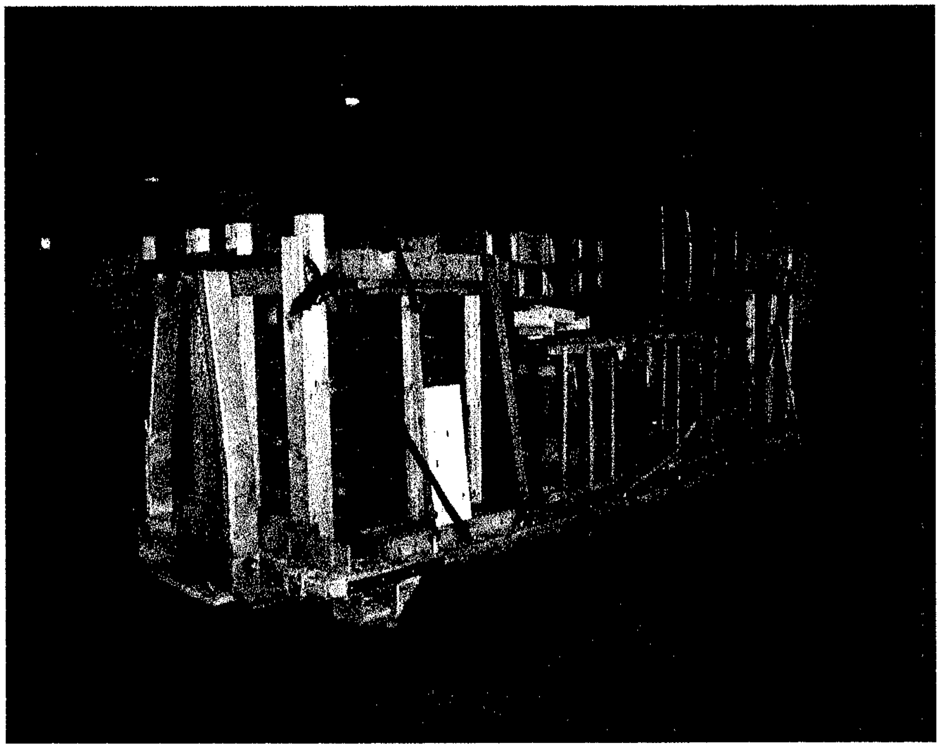
Specimen Load: 155MM in ISO Container on M872 trailer over road hazard.

Remarks: Load shifted vertically approximately 5 inches. Pin fell out of right rear restraint wall.

Test Date: 18 June 1998

Specimen Load: Strategic Configured Load (SCL) 23 on the PLS trailer.

Remarks: Pin fell out of right rear restraint wall. Pin fell out of center rear restraint wall. Side blocking needed. Summa trailer interface kit incompatible with Hyundai CROP. (See Photo 5).

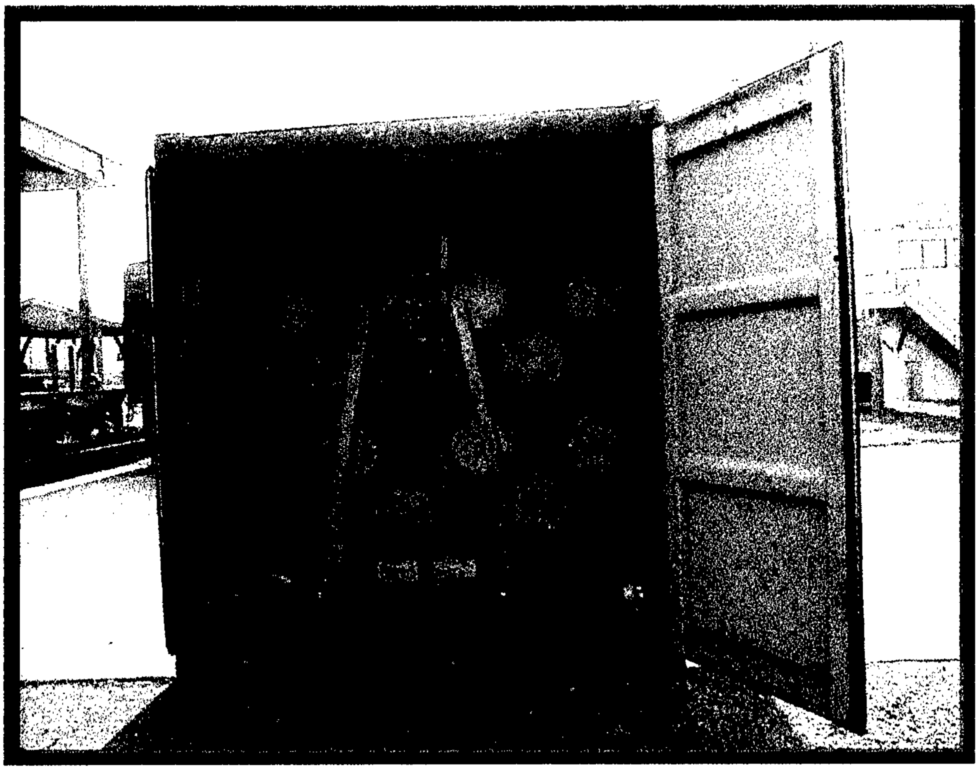


<u>Photo No. 5.</u> SCL #23 on the CROP

Test Date: 8 July 1998

<u>Specimen Load</u>: 105MM and MLRS in ISO container.

<u>Remarks</u>: No problems with the PLS. On MLRS the skids dished out CROP floor. The forward load restraint device dislodged.



<u>Photo No. 6.</u> MLRS pods on the CROP in an ISO container

Test Date: 24 August 1998

<u>Specimen Load</u>: 155MM on the PLS truck and 120MM on the PLS trailer.

<u>Remarks</u>: No problems with the CROP and/or load.

Test Date: 25 August 1998

<u>Specimen Load</u>: 120MM on the PLS truck and 155MM on the PLS trailer.

<u>Remarks</u>: No problems with the CROP and/or load.

Test Date: 26 August 1998

<u>Specimen Load</u>: 155MM and 120MM on the M872 trailer (center position).

<u>Remarks</u>: No problems with the CROP and/or load.

Test Date: 2 September 1998

Specimen Load: MLRS on PLS truck.

Remarks: Load swayed from side to side. No problems with the CROP and/or load.

Test Date: 28 September 1998

Specimen Load: MLRS on PLS truck and on M872 trailer.

Remarks: No problem with the CROP and/or load.

C. SHIPBOARD TRANSPORTATION SIMULATOR

Test Date: 22 October 1998

Specimen Load: 105MM in ISO container.

Remarks: CROP moved laterally 0.5 inch on roll. Top layer slid laterally and was overhanging at the bottom approximately 3 inches after 2.5 hours of testing. No problems with the CROP and/or load.

Test Date: 26 October 1998

Specimen Load: MLRS in ISO container.

Remarks: The top pods had no problems. The skids were squashed and slid laterally approximately 3 inches and stabilized. Load failed approximately 5 hours into testing. Load to be retested.

Test Date: 27 October 1998

Specimen Load: 155MM load in ISO container.

Remarks: No problems with the CROP and/or load.

Test Date: 4 November 1998

Specimen Load: MLRS in ISO container (retest).

Remarks: CROP passed testing. The load looked very good.

PART 6 – COMMENTS AND RECOMMENDATIONS

A. COMMENTS: The following problems were encountered during loading and unloading of the CROP from the ISO container:

1. The plastic rub strip tore off very easily while the extruded aluminum rub strips stayed in place and performed satisfactorily in those sections where they were installed. These plastic rub strips damaged the sides of the container walls.
2. The DIN locking plates (DIN locks) were sticking and continued to catch on the truck, precluding unloading. This was due to fore-aft movement of the A-frame.
3. The rear bumpers strike the ground before the rollers. As a result, they wear off very easily. If not corrected the bumpers will not survive in service.

Photo No. 7. Rear Bumpers

4. The container transport pins continue to be a problem. There is great concern about the number of parts and the possibility of losing them while in service, even though tethered. The design in the present form is unacceptable.

5. There is significant damage to the container floor from scraping of the rear ISO twist lock housings. The CROPs in their present form damage the container floor. The rollers are not low enough to preclude scraping the ISO container corners of the floor.

6. During the early stages of testing, there were concerns about the rear floorline blocking-restraint hinge rod. This rod rotates making it difficult to insert the cotter pin into the rod, which prevents rotation of the blocks when in the up position. This problem was solved by the addition of a tack weld to the rod, preventing it from rotating, so that the hole in the cotter pin will always be accessible. There was a similar problem at the front floor line blocks. The problem was corrected by the addition of tabs, which secured the blocks in place and prevented them from becoming loose and vibrating out. Front and aft supplemental restraints/blockers do not have positive retention when in the up position. These restraints could become dislodged or collapse during testing. The eyebolts used for holding the front supplemental restraints/blockers in their stored position are not tethered to structure and could be easily lost. The door end securement locks/slides will not engage the shoring slots of the door corner posts. There is no longitudinal adjustment of the securement lock to accommodate for various configurations of available containers. In addition, forklift markings are required on the side rails as an aid to the forklift operator.

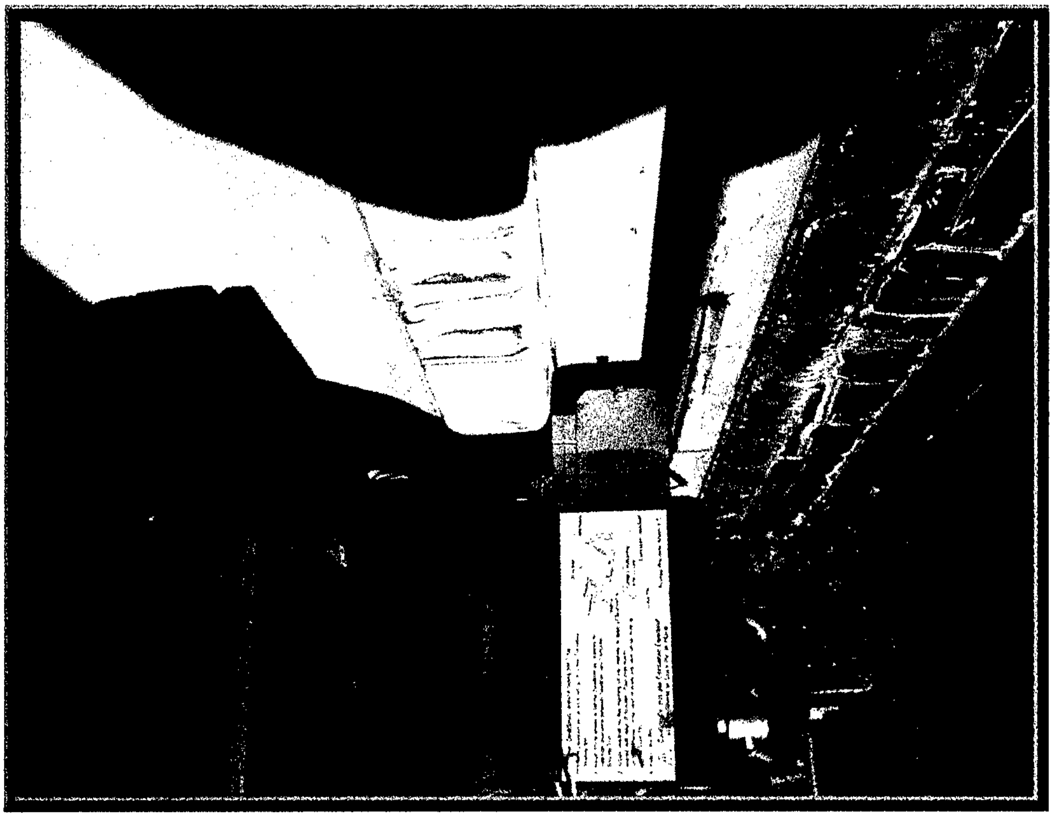


Photo No. 8. **Securement locks engaged in the shoring slots of the door corner posts**

7. The testing completed so far has identified many problems most of which have been addressed. The load tiedown has proved to be adequate. However, tiedown strap abrasion needs to be improved with an acceptable edge protection sleeve. The extruded aluminum rub strip was a better alternative to the plastic rub strip. To prevent damage to sections of the container, it was agreed that the extruded aluminum rub strip be continuous along the entire length of the side rail and not just in sections. Based upon the above tests and the data recorded, it was found that all of the first article Hyundai CROPs tested met the requirements of TP-94-01.

B. RECOMMENDATION: Recommend that the Hyundai CROPs be approved for full-scale production.